

- 13 end
- (c) exposing the liner layer to an isotropic plasma containing hydrogen ions, thereby densifying the liner layer, including sidewalls of the line layer; and
 - (d) forming a second conductive layer adjacent the liner layer in the via cavity, the second conductive layer substantially filling the via cavity to form the conductive via.

Please cancel claim 20 without prejudice or disclaimer.

REMARKS

Claims 1-20 are in the case. Claims 1 and 3-5 are rejected under 35 USC § 102 over USPN 6,323,121 to Liu et al. Claims 2 and 6-20 are rejected under 35 USC § 103 over Liu et al. in view of various combinations of one or more of USPN 6,365,495 to Wang et al., USPN 5,882,489 to Bersin et al., and USPN 6,133,143 to Lin et al. Claims 1, 7, and 9-11 have been amended and claims 6 and 20 are hereby cancelled. No new matter has been introduced by the amendments, which are supported by the disclosure of the original claims and the specification. Reconsideration and allowance of the claims are requested.

CLAIM OBJECTIONS

Claims 13 and 20 are objected to in that they are the same and depend on the same claim. Claim 20 is hereby cancelled. Reconsideration and allowance of claim 13 are hereby requested.

CLAIM REJECTIONS UNDER §102

Claims 1 and 3-5 are rejected under 35 U.S.C. 102 as being unpatentable over Liu et al. Independent claim 1 as amended claims a process for forming a conductive via including, *inter alia*, forming a via cavity in a first dielectric layer, etching the via cavity with a hydrogen-containing plasma, forming a liner layer in the via cavity, and *exposing the liner layer to an isotropic plasma of hydrogen and nitrogen ions*, thereby densifying the liner layer, *including sidewalls of the liner layer*.

Liu et al. describe a dry cleaning method for a damascene process. However, Liu et al. do not describe exposing a liner layer in a via cavity to an isotropic plasma

of hydrogen and nitrogen ions, which densifies the liner layer, including sidewalls of the liner layer. Thus, claim 1 as amended patentably defines over Liu et al. Reconsideration and allowance of claim 1 are respectfully requested.

Dependent claims 3-5 depend from independent claim 1, and contain additional important aspects of the invention. Therefore, dependent claims 3-5 patentably define over Liu et al. Reconsideration and allowance of dependent claims 3-5 are respectfully requested.

CLAIM REJECTIONS UNDER §103

Claims 6-7, 11-12, 15, and 17-19 are rejected under 35 U.S.C. 103(a) as being unpatentable over Liu et al. in view of Wang et al. Claim 6 is hereby cancelled. Dependent claim 7 depends from independent claim 1, which claims *inter alia*, forming a via cavity in a first dielectric layer, etching the via cavity with a hydrogen-containing plasma, forming a liner layer in the via cavity, and *exposing the liner layer to an isotropic plasma of hydrogen and nitrogen ions*, thereby densifying the liner layer, *including sidewalls of the liner layer*.

The deficiencies of Liu et al. in regard to these limitations are described at length above. Wang et al. do not compensate for the deficiencies of Liu et al., in that Wang et al. also do not describe the step of exposing a liner layer to an isotropic plasma of hydrogen and nitrogen ions. The office action contends that Wang et al. do describe such a step in column 10 lines 10-68, but this is an error. Wang et al. clearly state that "the RF power is applied to the showerhead 120 via a RF supply (not shown), with the chamber walls and pedestal forming the RF ground" (column 10 lines 36-39).

It is well known that an RF plasma created in the manner as described by Wang et al. is highly directional between the showerhead and the pedestal (the two electrodes), and is therefore *not isotropic*, but is rather *an anisotropic plasma*. Claim 1 as amended, upon which dependent claim 7 depends, recites an isotropic plasma, which therefore is not described by Wang et al. Further, Wang et al. make no mention of the problems of incomplete and inadequate densification of the sidewalls of the via cavity when using an anisotropic plasma, or any method to improve the densification of the sidewalls, as described and claimed in the present application.

Thus, claim 7 patentably defines over Liu et al. in view of Wang et al. Reconsideration and allowance of claim 7 are respectfully requested.

Similar to that as described above in regard to claim 1, claim 11 also claims, *inter alia*, exposing the liner layer to an isotropic plasma containing hydrogen ions, thereby densifying the liner layer, including sidewalls of the line layer. As described above, Liu et al. in view of Wang et al. do not describe such limitations. Therefore, independent claim 11 as amended patentably defines over Liu et al. in view of Wang et al. Reconsideration and allowance of independent claim 11 are respectfully requested.

Dependent claims 12, 15, and 17-19 depend from independent claim 11, and contain additional important aspects of the invention. Therefore, dependent claims 12, 15, and 17-19 patentably define over Liu et al. in view of Wang et al. Reconsideration and allowance of dependent claims 12, 15, and 17-19 are respectfully requested.

Claims 2 and 16 are rejected under 35 U.S.C. 103(a) as being unpatentable over Liu et al. in view of Wang et al., and further in view of Bersin et al. Claim 2 depends from claim 1, and therefore claims *inter alia*, forming a via cavity in a first dielectric layer, etching the via cavity with a hydrogen-containing plasma, forming a liner layer in the via cavity, and *exposing the liner layer to an isotropic plasma of hydrogen and nitrogen ions*, thereby densifying the liner layer, *including sidewalls of the liner layer*.

The deficiencies of Liu et al. in view of Wang et al. in regard to these limitations are described at length above. Bersin et al. do not remedy these deficiencies, in that Bersin et al. also do not describe exposing a liner layer to an isotropic plasma of hydrogen and nitrogen ions, thereby densifying the liner layer, including sidewalls of the liner layer.

Therefore, claim 2 patentably defines over Liu et al. in view of Wang et al. and further in view of Bersin et al. Reconsideration and allowance of claim 2 are respectfully requested.

Claim 16 depends from claim 11, and therefore claims *inter alia*, exposing the liner layer to an isotropic plasma containing hydrogen ions, thereby densifying the liner layer, including sidewalls of the line layer.

The deficiencies of Liu et al. in view of Wang et al. in regard to these limitations are described at length above. Bersin et al. do not remedy these

deficiencies, in that Bersin et al. also do not describe exposing the liner layer to an isotropic plasma containing hydrogen ions, thereby densifying the liner layer, including sidewalls of the line layer.

Therefore, claim 16 patentably defines over Liu et al. in view of Wang et al. and further in view of Bersin et al. Reconsideration and allowance of claim 16 are respectfully requested.

Claims 8-9, 13-14, and 20 are rejected under 35 U.S.C. 103(a) as being unpatentable over Liu et al. in view of Wang et al., and further in view of Lin et al. Dependent claims 8-9 depend from independent claim 1, and therefore claim *inter alia*, forming a via cavity in a first dielectric layer, etching the via cavity with a hydrogen-containing plasma, forming a liner layer in the via cavity, and *exposing the liner layer to an isotropic plasma of hydrogen and nitrogen ions*, thereby densifying the liner layer, *including sidewalls of the liner layer*.

The deficiencies of Liu et al. in view of Wang et al. in regard to these limitations are described at length above. Lin et al. do not remedy these deficiencies, in that Lin et al. also do not describe exposing a liner layer to an isotropic plasma of hydrogen and nitrogen ions, thereby densifying the liner layer, including sidewalls of the liner layer.

Therefore, claims 8-9 patentably define over Liu et al. in view of Wang et al. and further in view of Lin et al. Reconsideration and allowance of claims 8-9 are respectfully requested.

Claims 13-14 and 20 depend from claim 11, and therefore claim *inter alia*, exposing the liner layer to an isotropic plasma containing hydrogen ions, thereby densifying the liner layer, including sidewalls of the line layer.

The deficiencies of Liu et al. in view of Wang et al. in regard to these limitations are described at length above. Lin et al. do not remedy these deficiencies, in that Lin et al. also do not describe exposing the liner layer to an isotropic plasma containing hydrogen ions, thereby densifying the liner layer, including sidewalls of the line layer.

Therefore, claims 13-14 and 20 patentably define over Liu et al. in view of Wang et al. and further in view of Lin et al. Reconsideration and allowance of claims 13-14 and 20 are respectfully requested.

Claim 10 is rejected under 35 U.S.C. 103(a) as being unpatentable over Liu et al. in view of Lin et al., and further in view of Wang et al., and further yet in view of

Bersin et al. Independent claim 10 as amended claims, *inter alia*, exposing the titanium nitride liner layer to an isotropic plasma containing hydrogen ions, thereby densifying the titanium nitride liner layer, including sidewalls of the titanium nitride liner layer. The deficiencies of all of the cited references in regard to these limitations are described at length above.

Therefore, independent claim 10 patentably defines over Liu et al. in view of Lin et al., and further in view of Wang et al., and further yet in view of Bersin et al. Reconsideration and allowance of claim 10 are respectfully requested.

COMBINATION OF REFERENCES

Furthermore, it is respectfully submitted that the references cited do not support combining the elements as claimed in the present invention, and most especially in regard to the string of references cited again claim 10. *In re Bond*, 910 F.2d 831, 15 U.S.P.Q.2d (BNA) 1566 (Fed. Cir. 1990) states that the PTO erred in rejecting a claimed invention as an obvious combination of the teaching of prior art references when the prior art provided no teaching, suggestion, or incentive supporting the combination. *See Northern Telecom Inc. v. Datapoint Corp.*, 15 U.S.P.Q.2d 1321, 1323, *In re Geiger*, 2 U.S.P.Q.2D 1276, 1278. *SmithKline Diagnostics, Inc. v. Helena Laboratories Corp.*, 859 F.2d 878, 887, 8 U.S.P.Q.2d (BNA) 1468, 1475 (Fed. Cir.1988) states that one "cannot pick and choose among the individual elements of assorted prior art references to recreate the claimed invention."

There is nothing in the prior art cited to lead a person of ordinary skill to design a method like that of the present invention, other than the hindsight knowledge of this invention. The office action recites certain generalized benefits (realized in hindsight after considering the invention) as motivation for the combination of the references. However, these generalized motivations do not make obvious the combination of the references to produce the claimed invention. Only after considering the invention is it understood that combining the references (and adding a great deal more) tends to produce the motivating elements.

This, however, does not satisfy Section 103. The motivation to combine references cannot come from the invention itself. *See In re Oetiker*, 24 U.S.P.Q.2D 1443, 1446. The claims of the present application appear to have been used as a frame, and individual parts of separate prior art references were employed to recreate

a facsimile of the claimed invention. See *W.L. Gore & Assoc., Inc. v. Garlock, Inc.*, 220 U.S.P.Q. 303, 312. There is no explanation of what there was in the prior art that would have caused those skilled in the art to combine the references.

The examiner has the burden to show some teaching or suggestion in the references to support their use in the particular claimed combination. *Uniroyal Inc. v. Rudkin-Wiley Corp.*, 5 U.S.P.Q.2D at 1438-1439. In the absence of such, applicants respectfully suggest that the references are improperly combined.

CONCLUSION

Applicants assert that the claims of the present application patentably define over the prior art made of record and not relied upon for the same reasons as given above. A marked copy of the amendments is provided herewith. Applicants respectfully submit that a full and complete response to the office action is provided herein, and that the application is now in fully in condition for allowance. Action in accordance therewith is respectfully requested.

In the event this response is not timely filed, applicants hereby petition for the appropriate extension of time and request that the fee for the extension be charged to deposit account 12-2355. Should the examiner require further clarification of the invention, it is requested that he contact the undersigned before issuing the next office action.

Sincerely,

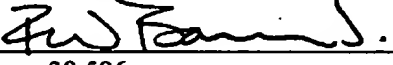
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MARKED COPY OF AMENDMENTS

IN THE CLAIMS

1. (amended) A process for forming a conductive via in an integrated circuit structure, where the integrated circuit structure includes a first dielectric layer overlying a first conductive layer, the process comprising:
 - (a) forming a via cavity in the first dielectric layer, the via cavity exposing the first conductive layer;
 - (b) etching the via cavity with a hydrogen-containing plasma;
 - (c) forming a liner layer in the via cavity;
 - (d) exposing the liner layer to an isotropic plasma of hydrogen and nitrogen ions, thereby densifying the liner layer, including sidewalls of the liner layer, and
 - ~~(de)~~ forming a second conductive layer adjacent the liner layer in the via cavity, the second conductive layer substantially filling the via cavity to form the conductive via.

Please cancel claim 6 without prejudice or disclaimer.

7. (amended) The process of claim 6-1 further comprising forming the isotropic plasma by microwave excitation of at least one of the combinations of gases including N₂H₂, NH₃ and N₂, and H₂.
9. (amended) The process of claim 1 wherein step ~~(de)~~ further comprises forming the second conductive layer of tungsten.
10. (amended) A process for forming a conductive via in an integrated circuit structure, where the integrated circuit structure includes a first dielectric layer overlying a first conductive layer, the process comprising:
 - (a) forming a via cavity in the first dielectric layer, the via cavity exposing the first conductive layer;
 - (b) forming a titanium layer over and adjacent the first conductive layer in the via cavity;

- (c) etching the via cavity with a hydrogen-containing plasma, thereby stripping carbon and oxygen from a residue on the first conductive layer in the via cavity;
 - (d) Argon sputtering the via cavity to at least partially remove the residue on the first conductive layer in the via cavity;
 - (e) forming a titanium nitride liner layer in the via cavity;
 - (f) exposing the titanium nitride liner layer to an isotropic plasma containing hydrogen ions, thereby densifying the titanium nitride liner layer, including sidewalls of the titanium nitride liner layer; and
 - (g) forming a tungsten layer adjacent the titanium nitride liner layer in the via cavity, the tungsten layer substantially filling the via cavity to form the conductive via.
11. (amended) A process for forming a conductive via in an integrated circuit structure, where the integrated circuit structure includes a first dielectric layer overlying a first conductive layer, the process comprising:
- (a) forming a via cavity in the first dielectric layer, the via cavity exposing the first conductive layer;
 - (b) forming a liner layer in the via cavity;
 - (c) exposing the liner layer to an isotropic plasma containing hydrogen ions, thereby densifying the liner layer, including sidewalls of the liner layer; and
 - (d) forming a second conductive layer adjacent the liner layer in the via cavity, the second conductive layer substantially filling the via cavity to form the conductive via.

Please cancel claim 20 without prejudice or disclaimer.